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# APPRENTICESHIP TRAINING

## ELECTRONIC TECHNICIAN Program

**Alberta**

MANPOWER  
Apprenticeship and Trade  
Certification Division

on  
6627316



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## COURSE OUTLINE

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## **ELECTRONIC TECHNICIAN TRADE**

### **THE GOAL OF APPRENTICESHIP TRAINING**

To develop a competent tradesman who, through skill and knowledge, is capable of the diagnosis and repair of radio and television receivers and other electronic equipment.

### **THE PRODUCT OF APPRENTICESHIP—**

a graduate who will:

- \* understand electrical and electronic theory and its application to radio, television and other equipment such as record players, tape recorders and inter-communication systems.
- \* be competent in the use of test instruments and understand their capabilities and limitations.
- \* have the dexterity and skill required to carry out the mechanical functions of completing repairs after locating the fault.
- \* be familiar with many different combinations of circuits and components.
- \* be capable of working out test procedures to isolate and pinpoint defective components.
- \* be able to meet the public and deal effectively with the customer, both in the shop and in the home.



## **ELECTRONIC TECHNICIAN APPRENTICESHIP INFORMATION**

### **Basic Requirements:**

- \* Indenture for four periods of Trade experience.
- \* Attend a 12 week technical training course in the first and second periods and a 6 week technical training course in the third and fourth periods.
- \* Fulfill the requirements for each period including 1800 hours of work experience inclusive of time spent at the training course and obtain a satisfactory employer's report.
- \* Education — a minimum requirement is the completion of grade 10 including a "B" standing in Math 10 or pass the entrance examination as prescribed by the Trade regulation.
- \* Age — the minimum age for apprentices is 16 years. There is no upper age limit.

### **Credits:**

- \* Accelerated patterns of apprenticeship may be granted for related technical training and/or experience.

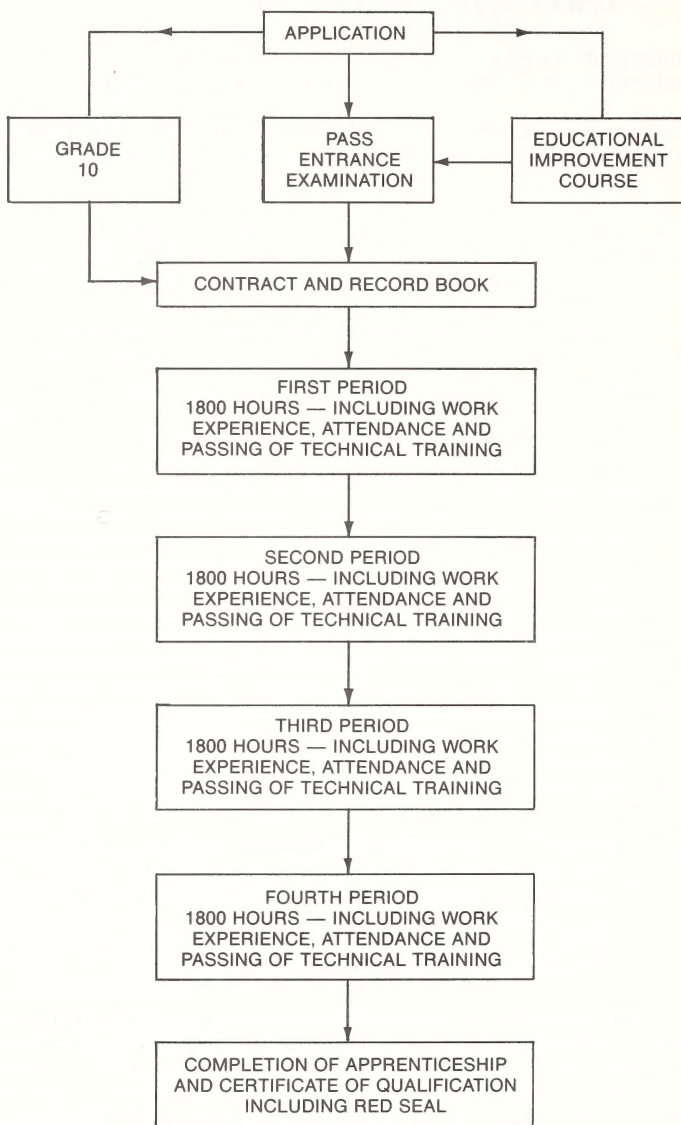
### **Benefits:**

- \* Apprenticeship is a learning-while-earning program. During the apprenticeship period, while working at the trade, apprentices are assured by regulation of a minimum percentage of the prevailing journeyman rate: 50% during the first period, 60% during the second period, 70% during the third period, 80% during the fourth period. Progress from one rate to the next takes place only after successful completion of all the requirements for each period (details are outlined in the Record Book).
- \* All apprentices 17 years of age and older are normally eligible for training allowances while attending technical training courses. These allowances are funded by the Canada Employment and Immigration Commission.
- \* Administrative procedures establishing the amount of training allowance is complex and can vary with an individual's circumstances. Contact a local Canada Employment Centre for details.
- \* An apprentice who successfully completes the program will graduate with an Alberta Completion of Apprenticeship Certificate and a Certificate of Qualification. It is also possible for the graduate to obtain an interprovincial Red Seal by passing an additional examination and so become recognized as a qualified tradesman throughout Canada.
- \* The most significant benefit to the graduate apprentice is that he is well trained in technical and practical aspects of the trade and is able to make a worthwhile and productive contribution to society. Society in return, will provide an opportunity for livelihood.

## **DIRECTIONS FOR PROSPECTIVE APPRENTICES**

- \* Contact your nearest Apprenticeship and Trade Certification Division for detailed information and counselling (see list of offices on page 55).
- \* Obtain an application form from the Apprenticeship and Trade Certification Division and neatly complete, in full, the information requested of the apprentice.
- \* Persevere in the search for apprentice employment and upon obtaining employment, give the application to the employer. It should be completed and returned to an Apprenticeship and Trade Certification Office forthwith.
- \* Any time credit, for previous experience in the Electronic Technician trade, should be discussed with the employer and requested on the application form by the employer.
- \* Attach to the apprenticeship application a copy (transcript) of the marks for your last year of school. Applicants who do not have their school transcripts or a grade 10 standing with a "B" in Math are required to write an entrance examination. If transcripts have been lost, contact Alberta Education for information on school transcripts.
- \* A contract of apprenticeship is entered into between the apprentice and the employer and should be signed within 90 days after the apprentice application has been approved. If contracts have not been issued within this time, contact the Apprenticeship and Trade Certification Division.
- \* Before signing the contract of apprenticeship read the complete document carefully — know your obligations and responsibilities to your employer — know the employer's obligations and responsibilities to you — feel confident you have selected the right occupation.
- \* Know when you will be expected to attend classes and be prepared to attend. In early May of each year, School Schedules are sent to you and your employer. The employer also receives a class selection card for you, which is to be completed and submitted for scheduling. Information on procedures also accompanies the above. Confirmation on the date you actually get scheduled and/or the Official Notice will follow at the appropriate time(s).
- \* Prepare in advance for the financial obligations required of you during school training. Reference materials and school supplies are paid for by the apprentice.
- \* While an apprentice, it will be your responsibility to respond promptly to mailed directions and requests from the Apprenticeship and Trade Certification Division.

## APPRENTICESHIP ROUTE TOWARD CERTIFICATION





## **APPRENTICESHIP COMMITTEE STRUCTURE**

### **Electronic Technician Provincial Apprenticeship Committee**

The Provincial Apprenticeship Committee for the Electronic Technician Trade is comprised of members from Local Apprenticeship Committees from the cities of Edmonton, Calgary and Red Deer.

This Committee is concerned with the policies that guide the program and make recommendations to the Apprenticeship and Trade Certification Board and the Director of the Apprenticeship and Trade Certification Division in the following areas;

- \* Contribute current information relative to changes in the trade and requirements of industry.
- \* Make recommendations for changes to existing trade regulations.
- \* Assist in updating of the training program through recommendations for revisions to the course outline and attendant examinations.

### **Electronic Technician Local Apprenticeship Committee**

Local Apprenticeship Committees are concerned with individuals and trade situations within a local region. Meetings are held throughout the year to make recommendations and to discuss problems relating to the apprenticeship program. Members who serve on committees are nominated by employer and labour organizations, and membership is equally divided into employer and employee representation in accordance with The Manpower Development Act.

### **Apprenticeship Committee Members:**

Mr. K. Ljunberg — Edmonton — Employer  
Mr. B. Zinger — Edmonton — Employer  
Mr. R. Chambers — Edmonton — Employee  
Mr. G. May — Edmonton — Employee  
Mr. L. Hamilton — Calgary — Employer  
Mr. S. Maier — Calgary — Employer  
Mr. V. Jewell — Calgary — Employee  
Mr. H. Milne — Calgary — Employee  
Mr. A. Jablonka — Calgary — Employee (Alternate)  
Mr. G. Fither — Calgary — Employer (Alternate)  
Mr. J. Johnson — Red Deer — Employee

## **ELECTONIC TECHNICIAN PROGRAM COURSE OUTLINE**

This outline has been prepared in accordance with recommendations from the Provincial Apprenticeship Committee for the Electronic Technician Trade in the Province of Alberta.

The outline was updated following consideration given to recommendations and suggestions from:

- Local Apprenticeship Committees
- Representatives from training institutes
- Curriculum Sub-Committee from the Provincial Apprenticeship Committee

### **PROCEDURES FOR RECOMMENDING REVISION(S) TO THE COURSE OUTLINE**

Any concerned citizen or group in the Province of Alberta may make recommendations for change by writing to Apprenticeship and Trade Certification Division, Edmonton.

It is requested that recommendations for change refer to specific areas and state references used. Recommendations received will be placed before regular meetings of the Provincial Apprenticeship Committee.

## **SAFETY EDUCATION**

Safe working procedures and conditions, accident prevention and the preservation of health is of primary importance in the Apprenticeship programs in Alberta. These responsibilities are shared and require the joint efforts of the government, employers, employees and the general public. Therefore, it is imperative that all parties become aware of circumstances that may lead to injury or harm and that safe learning experiences and environment can be created by controlling the variables and behaviors that may contribute to or cause an accident and/or an injury.

It is generally recognized that a safe attitude contributes to an accident free environment. As a result a healthy safe attitude towards accidents will benefit an employee by helping to avoid injury, loss of time and loss of pay.

A tradesman is possibly exposed to more hazards than any other person in the work force and therefore, should be familiar with the Occupational Health and Safety Act and Regulations dealing with his own personal safety and the special safety rules applying to each job.

### **LEGAL AND ADMINISTRATIVE ASPECTS**

#### **Employer's Responsibilities:**

Accident prevention and the provisions of safe working conditions are the responsibilities of an employer. The company is responsible for:

1. The provision and maintenance of safety equipment
2. The provision of protective devices and clothing
3. The enforcement of safe working procedures
4. Adequate safeguards for machinery, equipment and tools
5. Observance of all accident prevention regulations

#### **Government's Responsibilities:**

The Apprenticeship and Trade Certification Division in conjunction with the respective Provincial Apprenticeship Committee assumes the responsibility to assure that adequate safety is reflected in the curriculum and that adequate safety instruction is presented at the training establishments.

The Occupational Health and Safety Inspection Branch assumes the responsibility for periodic inspection of the operation to ensure that regulations for industry are being correctly observed.

#### **Individual's Responsibilities:**

The employee is responsible for:

1. Knowing and working in accordance with the safety regulations pertaining to job environment and
2. Working in such a way as not to endanger himself or his fellow employees

The major factor in safety is the individual employee, his personal attitude toward safety and having an awareness of the respective safety regulation.

## ELECTRONIC TECHNICIAN PROGRAM

### Subjects and Time Distribution

<b>First Period</b>	<b>12 Weeks</b>	<b>30 Hours Per Week</b>	<b>360 Hours</b>	<b>Page</b>
Section One:	Basic Electronics (Theory)		144	9
Section Two:	Basic Electronics (Lab)		144	18
Section Three:	Trade Mathematics		72	25
<b>Second Period</b>	<b>12 Weeks</b>	<b>30 Hours Per Week</b>	<b>360 Hours</b>	<b>Page</b>
Section One:	Advanced Electronics (Theory)		168	28
Section Two:	Advanced Electronics (Lab)		156	31
Section Three:	Trade Mathematics		36	34
<b>Third Period</b>	<b>6 Weeks</b>	<b>30 Hours Per Week</b>	<b>180 Hours</b>	<b>Page</b>
Section One:	TV Receivers (Theory)		78	37
Section Two:	TV Receivers (Lab)		72	42
Section Three:	Digital Fundamentals		30	45
<b>Fourth Period</b>	<b>6 Weeks</b>	<b>30 Hours Per Week</b>	<b>180 Hours</b>	<b>Page</b>
Section One:	Color Television (Theory)		84	47
Section Two:	Color Television (Lab)		66	50
Section Three:	Video Tape Recorders		18	52
Section Four:	Digital Fundamentals II		12	53

## FIRST PERIOD TECHNICAL TRAINING

### SECTION ONE: BASIC ELECTRONICS (THEORY)

144 Hours

#### A. Fundamental Concepts of Electricity

6 Hours

1. Introduction
  - (a) practical application of general principles of electricity
  - (b) development of electronics
  - (c) radio communications and broadcast
  - (d) television broadcasting
  - (e) importance of trade terminology
2. Negative and positive polarities
3. Electrons and protons in an atom
4. Structure of an atom
5. The coulomb unit of charge
6. The volt unit of potential difference
7. Charge in motion — current
8. Resistance — opposition to current
9. The closed circuit
10. Direct Current (D.C.) and alternating current (A.C.)
11. Sources of electricity

#### B. Ohm's Law

4 Hours

1.  $I = \frac{E}{R}$ ,  $E = IR$ ,  $R = \frac{E}{I}$
2. Multiple and submultiple units
3. Linear proportion between E & I
4. Inverse relation between I & R
5. Power and dissipation in resistance
6. Electric shock

#### C. D.C. Circuits

24 Hours

1. Series
  - (a) current in series circuits
  - (b) total resistance
  - (c) voltage drops
  - (d) polarity of IR drops
  - (e) power in series circuits



- (f) analyzing series circuits
- (g) effects of an open in a series circuit
- 2. Parallel
  - (a) voltage across parallel branches
  - (b) branch current
  - (c) line current
  - (d) resistances in parallel
  - (e) conductances in parallel
  - (f) total power in parallel circuits
  - (g) analyzing parallel circuits
  - (h) effect of an open on a parallel circuit
- 3. Series-parallel
  - (a) finding  $R_T$  for series-parallel resistances
  - (b) resistance strings in parallel
  - (c) resistance banks in series
  - (d) resistance banks and strings in series-parallel
  - (e) analyzing series-parallel circuits

#### **D. Direct Current Meters**

**4 Hours**

- 1. Moving coil meter
- 2. Measurement of current
- 3. Meter shunt
- 4. Voltmeter
- 5. Ohmmeters
- 6. Multimeters
- 7. Digital Voltmeters D.V.M.s\*
- 8. Digital Multimeters D.M.M.s\*
- 9. Meter applications
- 10. Checking continuity with the ohmmeter

#### **E. Conductors and Insulators**

**4 Hours**

- 1. Purpose
- 2. Types
- 3. Standard wire gauge sizes
- 4. Switches
- 5. Fuses
- 6. Pilot lamps
- 7. Wire resistive
- 8. Ion current in liquids and gases

9. Electron and hole charges in semiconductors
10. Insulators

**F. Resistors**

**4 Hours**

1. Types
2. Variable
3. Resistor color coding
4. Power rating
5. Choosing resistors for a circuit
6. Series and parallel combinations of resistors
7. Resistor troubles

**G. Batteries**

**4 Hours**

1. Function of batteries
2. The voltaic cell
3. The carbon-zinc dry cell
4. Series and parallel cells
5. The lead-acid wet cell
6. Types of electromotive cells, Nicad, Lithium\*
7. Internal resistance of a D.C. source
8. Matching a load resistance to a source

**H. Magnetism**

**4 Hours**

1. The magnetic field
2. Magnetic flux
3. Flux density
4. Induction by magnetic field
5. Air gap of a magnet
6. Types of magnets
7. Magnetic shielding
8. Permeability
9. B-H magnetization curve
10. Magnetic hysteresis

- |  |                 |
|--|-----------------|
| <b>I. Electromagnetic Induction</b>  | <b>4 Hours</b>  |
| <ul style="list-style-type: none"><li>1. Magnetic field around an electric current</li><li>2. Magnetic polarity of a coil</li><li>3. Motor action between two magnetic fields</li><li>4. Induced current</li><li>5. Len's Law</li><li>6. Generating an induced voltage</li><li>7. Faraday's Law of induced voltage</li></ul>   |                 |
| <b>J. Alternating Voltage and Current</b>  | <b>7 Hours</b>  |
| <ul style="list-style-type: none"><li>1. Alternating-voltage generator</li><li>2. The sinewave</li><li>3. Alternating current</li><li>4. Voltage current values for a sinewave</li><li>5. Frequency and wavelength</li><li>6. Phase angle</li><li>7. Time factor in frequency and phase</li><li>8. A.C. circuits with resistance</li><li>9. The 60 Hz A.C. power line</li><li>10. Motors and generators</li><li>11. Non-sinusoidal A.C. waveforms</li><li>12. Harmonic frequencies</li></ul> |                 |
| <b>K. Inductance, Inductive Reactance and Inductive Circuits</b>   | <b>10 Hours</b> |
| <ul style="list-style-type: none"><li>1. Induction by alternating current</li><li>2. Self-inductance</li><li>3. Self-induced voltage</li><li>4. How <math>e_L</math> opposes a change in voltage</li><li>5. Mutual inductance</li><li>6. Transformers</li><li>7. Core losses and types of cores</li><li>8. Variable inductance</li><li>9. Inductances in series and parallel</li><li>10. Stray inductance</li></ul>  |                 |

11. Troubles in coils
12. How XL reduces amount of alternating current
13.  $X_L = 2 \pi f L$
14. Series and parallel inductive reactances
15. Ohm's Law applied to  $X_L$
16. Application of inductive reactance
17. Waveshape of  $e_L$  induced by sinewave current
18. Current and voltage phase relation in series and parallel
19. Inductive reactances and resistances in series and parallel
20. L/R time constant
21. High voltage produced by opening RL circuits
22. Comparison of time constant and reactance

**L. Capacitance, Capacitive Reactance and Capacitive Circuits    10 Hours**

1. How charge is stored in the dielectric
2. Charging and discharging capacitors
3. Unit of capacitance
4. Typical capacitors
5. Capacitor color coding
6. Capacitances in series and parallel
7. Stray capacitive and inductive effects
8. Energy in electrostatic field of capacitance
9. Troubles in capacitors
10. How A.C. voltage produces A.C. current in capacitive circuit
11.  $X_C = \frac{1}{2 \pi f C}$
12. Series and parallel capacitive reactances
13. Ohm's Law applied to  $X_C$
14. Application of capacitance reactance
15. Charge and discharge current
16. Voltage and current phase relationships in capacitive circuits
17. Capacitive reactance in series and parallel circuits
18. Capacitive voltages dividers

19. R.F. and A.F. coupling capacitors
20. R.C. time constant and wave shapes
21. Long and short time constants
22. Universal time constant graph
23. Comparison of time constant and reactance

**M. Alternating Current Circuits**

**6 Hours**

1. A.C. resistance circuits
2. A.C. inductance circuits
3. A.C. capacitive circuits
4. Opposite reactances
5. Reactances and resistances in
  - (a) series
  - (b) parallel
6. Real power
7. A.C. meter and wattmeters
8. Types of phasors in A.C. circuits

**N. Resonance**

**3 Hours**

1. The resonance effect
2. Series resonance
3. Parallel resonance
4. Calculating resonant frequency
5. Q magnification factor
6. Bandwidth of a resonant circuit
7. Tuning
8. Mistuning
9. Analysis of parallel resonant circuit
10. Damping of parallel resonant circuits
11. Choosing L and C for a resonant circuit

**O. Filters**

**6 Hours**

1. Examples of filtering
2. Direct current combined with A.C.
3. Transformer coupling



4. Capacitive coupling
5. Bypass capacitors
6. Filter circuits
7. Low pass filters
8. High pass filters
9. Interference filters

**P. Semiconductor Diodes**

**6 Hours**

1. Introduction
2. Types
3. Characteristics
  - (a) germanium
  - (b) silicon
4. Conductors
  - (a) hole concept
  - (b) free electron movement
  - (c) n-type doping (impurities added)
  - (d) p-type doping (impurities added)
  - (e) minority carriers
  - (f) majority carriers
5. Type P-N Junction Diode
  - (a) forward voltage
  - (b) reverse voltage
  - (c) voltampere characteristic
  - (d) diode symbols and ratings
  - (e) diode rectified circuits
    - (i) half-wave
    - (ii) full-wave
    - (iii) operating characteristics
6. Zener and varactor diodes
  - (a) symbols and ratings
  - (b) characteristics
  - (c) applications
7. Thyristors
  - (a) types
    - (i) silicon controller rectified
    - (ii) diac
    - (iii) triac
  - (b) symbols and ratings
  - (c) characteristics
  - (d) applications

**Q. Transistors****4 Hours**

1. NPN and its symbol
2. PNP and its symbol
3. Transistor principle and action
4. Emitter base and collector current
5. Biasing transistors
6. Characteristic curves
  - (a) general description
  - (b) reading the collector characteristics
  - (c) delta values
  - (d) regions of operation
  - (e) input and temperature curves
7. Transistor amplifier configurations

**R. Common Base Circuit****4 Hours**

1. Characteristics — Alpha
2. General description
3. Biasing method
4. Q-point analysis
5. D.C. equivalent circuit
6. Circuit limits — large signal, small signal
7. Circuit examples

**S. The Common Emitter (CE) Circuit****4 Hours**

1. Characteristics — Beta
2. Methods of biasing
3. Q-point analysis
4. D.C. equivalent circuit
5. Signal inversion
6. Temperature characteristics
7. Circuit limits — large signal, small signal
8. Circuit examples

**T. Common Collector Circuit****4 Hours**

1. General description
2. Circuit operation

3. Biasing and emitter follower
4. Q-point analysis
5. Signal response
6. Equivalent circuit
7. Application
8. Circuit examples

#### **U. Transistor Circuits**

**4 Hours**

1. Circuit components
2. Beta-dependent circuits
3. Biasing and emitter follower
4. Bias
5. Basic ideas of signal conditions
6. Amplifier-circuit characteristics
7. Coupling methods
8. Circuit limits

#### **V. Field-Effect Transistors**

**4 Hours**

1. Symbol and general description
2. Characteristics and application
3. Junction-gate field-effect transistors (JFETs)
  - (a) symbol and general description
  - (b) application
4. Metal-oxide semiconductor field-effect transistor (MOSFETs)
  - (a) types and symbols
  - (b) application

#### **W. Power Supplies**

**8 Hours**

1. Function
2. Power transformer
3. Rectifiers
  - (a) half-wave
  - (b) bridge
  - (c) voltage doublers
  - (d) voltage triplers
4. Transformerless power supplies
5. Typical A.C. power supply

6. Voltage regulators
7. Regulated power supply
8. Power supply problems

**X. Electron Tubes and Amplifiers 2 Hours**

1. Construction
2. Types and application
3. Voltage gain
4. Various coupling methods
5. Methods of biasing
6. D.C. and A.C. voltages in the amplifier
7. Troubles in amplifier circuits

**Y. A.M. Receiver (Solid-State) 2 Hours**

1. Block diagram
2. Stage functions

**Z. F.M. Receivers (Solid-State) 2 Hours**

1. Block diagram
2. Stage functions
3. F.M. stereo receiver
  - (a) block diagram
  - (b) stage functions.

**SECTION TWO: BASIC ELECTRICITY (LAB) 144 Hours**

General Objectives:

1. To give an apprentice an understanding of proper and safe use of trade testing equipment and instruments.
2. To assist in the development of essential trade skills and systematic troubleshooting procedures. Arranging and carrying out well-planned shop activities relating to the basic function of components and circuits found in the Electronic Technician Trade. By instruction in the use of modern test instruments, to further increase his productivity.
3. To reinforce the theory instruction by enabling the apprentice to gain practical circuit knowledge.

**A. Orientation 4 Hours**

1. Shop rules and procedure
2. Safety

3. Basic components and their symbols
4. Schematic diagrams
5. Soldering

**B. Meters**

**7 Hours**

1. Proper use and care
2. Function and range switches
3. Ranges
4. Meter error
5. Meter leads
6. Safety precautions
7. Resistor color code
8. Measuring resistance

**C. Dry Cells**

**4 Hours**

1. Series
  - (a) opposing
  - (b) aiding
2. Parallel
3. Series-Parallel
4. Care and application
5. Measuring D.C. voltages

**D. D.C. Power Supply**

**2 Hours**

1. Low voltage, high current sources
2. High voltage, low current sources
3. Application
4. Voltage measurements
5. Current measurements
6. Internal resistance

**E. The Series Circuit**

**6 Hours**

1. Live current
2. Voltage and voltage drop
3. Total resistance and total power
4. Application of Ohm and Kirchhoff's Laws



5. Series circuit design considerations

6. Troubleshooting

**F. Parallel Circuit**

**6 Hours**

1. Total resistance

2. Live current

3. Branch currents

4. Voltage and voltage drops

5. Power and resistance characteristics

6. Application of Ohm and Kirchhoff's Law

7. Parallel circuits design considerations

8. Troubleshooting

**G. Series-Parallel Circuit**

**6 Hours**

1. Current

(a) branch

(b) total

2. Voltage

(a) applied and across each branch

(b) across each component

3. Total resistance and total power

4. Checking resistors for open

5. Troubleshooting

**H. Voltage Divider Circuits**

**6 Hours**

1. Loaded and unloaded

2. Series connected

3. Variable

4. Design considerations

**I. Meters**

**6 Hours**

1. Meter movement

(a) sensitivity

(b) internal resistance

2. Ammeter shunts

3. Voltmeter multipliers

4. Input resistance of voltmeters

5. Ohmmeters

6. D.V.M.'s use of (digital voltmeters)
7. D.M.M.'s use of (digital multimeters)
8. Precautions when using

**J. Cathode Ray Oscilloscope 6 Hours**

1. Function, use and care
2. Operation of single trace, dual trace
3. Operation of delayed sweep
4. Application

**K. Alternating Current and Voltage 4 Hours**

1. Sine wave
  - (a) peak value
  - (b) r.m.s. value
  - (c) cycle
  - (d) frequency
  - (e) wavelength
2. Angular measure
3. Radian measure
4. Phase angle

**L. Inductance (Coils) and Inductive Reactance 9 Hours**

1. Inducing a voltage in a coil
  - (a) electromagnetic induction
  - (b) polarity and magnitude
2. Inductance and reactance of a coil
3. Resistance of a coil
4. Effect of inductance on current in D.C. and A.C. circuits
5. Measurement of  $X_L$
6. Verify that  $X_L = 2\pi fL$
7. Back E.M.F.
8. Phase relations between  $I$  and  $E$  in inductive circuits
9. Open coil
10. RL time constant

**M. Transformers 3 Hours**

1. Ideal transformer
2. Power losses

3. Effect of load current on primary current
4. Resistance-testing transformer windings
5. Turns ratio
6. Application

**N. Capacitors, Capacitance and Capacitive Reactance**

**9 Hours**

1. Color code
2. Capacitors in series and parallel
3. Determining value of capacitors
4. Effects of capacitance on current in D.C. and A.C. circuits
5. Measurement of XC
6. Verify that  $X_C = \frac{1}{2\pi fC}$
7. Phase relations between I and E in capacitive circuits
8. R.C. time constants
9. Testing capacitors for:
  - (a) open
  - (b) short
10. Capacitive voltage dividers

**O. Series RCL Circuits**

**6 Hours**

1. Impedance of series R.C. circuit
2. Impedance of series R.L. circuit
3. Verify that  $Z = R + (X_L - X_C)$
4. Current and voltage
5. Series resonant circuit
  - (a)  $f_r = \frac{1}{2\pi LC}$
  - (b) line currents
  - (c) impedance and voltage
  - (d) circuit Q and frequency response
  - (e) circuit Q and bandwidth
  - (f) application

**P. Parallel RLC Circuits**

**6 Hours**

1. Current and voltage
2. Impedance

3. Parallel and resonant circuit
  - (a) line current
  - (b) impedance and voltage
  - (c) application

**Q. Filters** **3 Hours**

1. Circuits
2. Low pass
3. High pass
4. Frequency response curves

**R. Phase Shift Networks** **3 Hours**

1. RC phase-shifting network
2. Phase-shifting bridge circuit

**S. Thermistors and Varistors (V.D.R.'s)** **2 Hours**

1. Characteristics
2. Types
3. Applications

**T. Semiconductor Diodes** **18 Hours**

1. Junction diodes
  - (a) characteristics
  - (b) operation
  - (c) testing
  - (d) application
2. Zener diodes
  - (a) characteristics
  - (b) operation
  - (c) ratings
  - (d) application
  - (e) design considerations
3. Varactor diodes
  - (a) characteristics
  - (b) rating
  - (c) operation
  - (d) application
4. Half-wave and full-wave rectification
  - (a) voltampere characteristics of silicon rectifiers
  - (b) Rectifier circuits
    - (i) transformerless
    - (ii) transformer type

5. Transformer power supply and filter
  - (a) operation
  - (b) regulation
  - (c) application
6. The voltage doubler using silicon rectifiers
  - (a) transformerless
7. Bridge rectifier
  - (a) transformer operated
  - (b) operation and overload protection
  - (c) filtering output
  - (d) troubleshooting
8. Servicing of power supply systems

**U. Transistor Familiarization**

**6 Hours**

1. Structure and symbols
2. Junction-transistors
  - (a) N.P.N.
  - (b) P.N.P.
3. Forward and reverse bias
4. Measurements in transistor circuits
5. Testing procedures
6. Characteristic curves
7. Thermal runaway
8. Ratings

**V. Common Base Amplifiers (CB)**

**7 Hours**

1. Circuit arrangement
2. Current gain — Alpha
3. Voltage gain
4. Power gain
5. Input and output impedance
6. Phase relations
7. Biasing methods
8. Application and operation
9. Troubleshooting a CB amplifier

**W. Common Emitter Amplifiers (CE)**

**10 Hours**

1. Circuit arrangement
2. Current gain — Beta



3. Average collector characteristics (VCE versus IC)
4. Voltage gain
5. Power gain
6. Input and output impedance
7. Phase relations
8. Biasing methods and stabilization
9. Emitter bypass capacitor
10. Voltage divider bias
11. Troubleshooting a common emitter amplifier
12. Application and operation

**X. Common Collector Amplifiers (CC) Emitter Follower** **4 Hours**

1. Circuit arrangement
2. Current gain
3. Voltage gain
4. Power gain
5. Input and output impedance
6. Phase relations
7. Biasing methods
8. Application and operation
9. Troubleshooting an emitter follower

**Y. Record Players and Tape Recorders** **1 Hour**

1. Adjustment on tone arm
  - (a) height
  - (b) indexing
  - (c) anti-skate
  - (d) counter-balance
2. Head adjustments
  - (a) height
  - (b) azimuth

**SECTION THREE: TRADE MATHEMATICS** **72 Hours**

**A. Basic Mathematics** **16 Hours**

1. Review of:
  - (a) whole numbers
  - (b) common fractions

- (c) decimal fractions
  - (d) percentage
  - (e) factoring
  - (f) ration and proportion
  - (g) fundamentals of algebra
2. Powers of ten
- (a) scientific notation
    - (i) multiply
    - (ii) divide
    - (iii) raise to a power
    - (iv) add and subtract
  - (b) electronic calculator
    - (i) proper use
    - (ii) electronic notation

**B. Direct Current Circuit Problems and Solutions**

**16 Hours**

- 1. Ohm's Law ( $E = IR$  and its variations)
- 2. Power Law ( $P = IE$  and its variations)
- 3. Formula manipulation
- 4. Series resistive circuit problems (include transistors)
- 5. Parallel resistive circuit problems (include transistors)
- 6. Series-parallel resistive problems (Kirchhoff's Law)
- 7. Voltage dividers and bias network
- 8. Internal resistance
- 9. Meter shunts and multipliers

**C. Alternating Current Mathematics**

**30 Hours**

- 1. Fundamentals
  - (a) sinewave
  - (b) vector representation
    - (i) graphical representation of  $Z$ ,  $X_L$ ,  $X_C$ ,  $R$ ,  $W$  and  $VA$
    - (ii) solve using a vector method for the unknown
  - (c) cycle, frequency and wavelength
  - (d) voltage and current equations
  - (e) effective, peak and instantaneous values of current and voltage
  - (f) phase relationships and phase angles
- 2. Trigonometric functions
  - (a) properties and solution of right angle triangle
  - (b) trigonometric ratios
    - (i) sine
    - (ii) cosine
    - (iii) tangent
  - (c) use of mathematical tables

- (d) trigonometric solution of AC circuits
  - (i) voltage
  - (ii) current
  - (iii) power
  - (iv) impedance

3. Series AC circuit problems

- (a) resistive
- (b) inductive
- (c) capacitive
- (d) LR, CR and LCR
- (e) power
- (f) resonance
- (g) time constants (LR and CR)

4. Parallel AC circuit problems

- (a) resistive
- (b) inductive
- (c) capacitive
- (d) LR, CR and LCR
- (e) power
- (f) resonance

**D. Complex AC Circuit Problems**

**4 Hours**

- 1. Find current, voltage and power gains in:  
low-pass, high pass and band-pass amplifier stages
- 2. Determine signal gain in audio circuits
- 3. Convert wavelength to frequency
- 4. Impedance matching problems

**E. Logarithms**

**6 Hours**

- 1. Definition of common logarithms
- 2. Laws of logarithms
- 3. Use of logarithmic tables
- 4. Application of logarithms

## SECOND PERIOD TECHNICAL TRAINING

## SECTION ONE: ADVANCED ELECTRONICS (THEORY)

## 168 Hours

### A. Review of Transistor Circuits

## 28 Hours

1. Transistor temperature characteristics
2. Bias methods
3. Field effect transistors
4. Common emitter — common source circuits
5. Common base — common gate circuits
6. Common collector — common drain circuits
7. Linear transistor circuits
8. Transistor parameters
9. Integrated circuits
10. Silicon controlled rectifiers — diacs, triacs
11. Review of tubes
12. Review of power supplies

## B. Basic Audio Amplifier Circuits

## 18 Hours

1. Sound waves and audio frequencies
2. Basic transformerless output circuits
3. Audio preamplifier circuits
4. Audio output stages
5. Single-ended audio circuits
6. Push-pull amplifier
7. Phase splitter
8. Volume and tone control circuits
9. Types of distortion
10. Negative feedback
11. Servicing audio circuits

### C. R.F. and I.F. Amplifier Circuits

## 14 Hours

1. R.F. amplifier — functions
2. I.F. amplifier — functions
3. Coupling methods

4. Frequency bandpass
5. A.V.C. and A.G.C. circuits
6. Alignment
7. Servicing I.F. and R.F. circuits

**D. Oscillators**

**6 Hours**

1. Tuned circuit oscillator
  - (a) Tickler
  - (b) Armstrong
  - (c) Colpitts
  - (d) Hartley
  - (e) Crystal
  - (f) resistance — capacitance
2. Servicing oscillator circuits

**E. Modulation and Detection**

**8 Hours**

1. Double sideband — AM
2. Single sideband — AM
3. Suppressed carrier
4. F.M.
5. Phase modulation
6. Basic A.M. detection
7. Basic F.M. detection

**F. A.M. Receiver (Solid-State)**

**24 Hours**

1. R.F. amp (include antenna)
2. Converter mixer
3. I.F. stages
4. Detector
5. Audio amplifier
6. Power supply
7. Alignment of A.M. receivers
8. Servicing A.M. receivers
9. Servicing auto receivers

**G. F.M. Receivers (Solid-State)**

**14 Hours**

1. R.F. amplifiers
2. Oscillator — mixer

3. A.F.C. circuits
4. I.F. amplifier
5. Limiter
6. F.M. detector
7. Alignment
8. Servicing F.M. receivers

#### **H. Stereo F.M. Receivers (Solid-State)**

**14 Hours**

1. F.M. stereo system
2. S.C.A. signal
3. Block diagram
4. Detector circuits
5. Stereo receiver circuits
6. Stereo F.M. alignment
7. Servicing stereo F.M. receivers

#### **I. Stereo Audio Amplifiers**

**10 Hours**

1. Audio output circuits
  - (a) push-pull
  - (b) stacked, etc.
2. Differential amplifiers
3. Distortion and feedback
4. Speaker enclosures
5. Reproducers — microphones, etc.

#### **J. Tape Recorders**

**12 Hours**

1. Physical layout and components
2. Heads and head adjustment
  - (a) record
  - (b) erase
  - (c) playback
3. Tape and tape speeds
4. Frequency response
5. Distortion — wow, flutter, hum, etc.
6. Bias oscillators and biasing



7. Equalization
8. Tape recorder circuits

**K. Black and White — Color T.V. Receivers** **10 Hours**

1. Block diagram
2. Stage functions
3. Customer controls
4. Technician controls
5. Convergence controls
6. Basic T.V. servicing

**L. N.T.S.C. Color System** **10 Hours**

1. Additive color fundamentals
2. Luminance signals
3. Chroma signal
4. Burst signal
5. Transmission of color information
6. Demodulation of color information
7. Basic color circuits
8. Basic convergence circuits
9. Color picture tube

**SECTION TWO: ADVANCED ELECTRONICS (LAB)** **156 Hours**

**A. Record Changers** **6 Hours**

1. Motors — A.C. and D.C.
2. Mechanical operation
3. Bearings and lubrication
4. Drive mechanisms — cleaning and lubrication
5. Cartridges
  - (a) magnetic
  - (b) crystal
  - (c) ceramic
6. Distortion due to mechanical faults
  - (a) wow
  - (b) flutter

- (c) hum
- (d) etc

7. Regulated supply for D.C. motor type

8. Adjustments

## **B. Transistor Amplifier Circuits**

**28 Hours**

1. Common base amplifier
2. Common emitter amplifier
3. Common collector amplifier
4. Troubleshooting audio amplifier circuits
5. Field-effect transistors
  - (a) types
  - (b) operation
  - (c) application

## **C. Basic Audio Amplifier Circuits**

**22 Hours**

1. Class A audio power amplifier and the loudspeaker
  - (a) dynamic speaker
  - (b) output transformer
  - (c) servicing class A power amplifier circuit
2. Push-pull power amplifier
  - (a) class B operation
  - (b) complementary symmetry one and two power supply
  - (c) servicing
3. Frequency response of an audio amplifier
  - (a) frequency response
  - (b) use of negative feedback
4. Single-ended audio circuits
5. Audio preamplifier circuits
6. Phase splitter
7. Servicing audio amplifier circuits
8. Integrated circuits, the linear amplifier

## **D. Silicon Controlled Rectifier**

**6 Hours**

1. Characteristics (review)
2. Ratings (review)
3. Applications and circuit measurements
4. Use with U.J.T. for triggering

- E. R.F. and I.F. Amplifier Circuits** **12 Hours**
1. Coupling methods
  2. A.V.C. and A.G.C. circuits
  3. Servicing I.F. and R.F. circuits
- F. Oscillators** **8 Hours**
1. Hartley oscillator
    - (a) oscillator "tank" circuit
    - (b) Ticker coil oscillator
    - (c) series-fed Hartley oscillator
    - (d) parallel-fed Hartley oscillator
    - (e) checking oscillator frequency
  2. Phase shift transistor oscillator
  3. Armstrong oscillator
  4. R.C. coupled oscillators
  5. Collector-coupled multivibrator
  6. Sawtooth generator
  7. Transistor voltage mode trigger
  8. Servicing oscillator circuits
- G. Modulation and Detection** **4 Hours**
1. Double sideband A.M.
  2. Single sideband A.M.
  3. Frequency modulation
  4. Phase modulation
  5. Basic A.M. detector circuits
  6. Servicing detector circuits
- H. A.M. Radio Receivers** **22 Hours**
1. Circuit fault analysis
    - (a) power supplies
    - (b) audio stages
    - (c) detector stage
    - (d) I.F. stages
    - (e) converter stage
    - (f) R.F. stages
  2. Signal generator and alignment
  3. Servicing A.M. receivers

<b>I. F.M. Radio Receivers</b>	<b>20 Hours</b>
<ul style="list-style-type: none"> <li>1. Circuit fault analysis <ul style="list-style-type: none"> <li>(a) R.F. amplifier stages</li> <li>(b) oscillator-mixer stage</li> <li>(c) A.F.C. circuits</li> <li>(d) I.F. amplifier stages</li> <li>(e) limiter circuits</li> <li>(f) F.M. detector circuits</li> <li>(g) audio stages</li> </ul> </li> <li>2. Sweep generator, marker generator and alignment</li> <li>3. Servicing F.M. receivers</li> </ul>	
<b>J. Stereo F.M. Receivers</b>	<b>14 Hours</b>
<ul style="list-style-type: none"> <li>1. Circuit fault analysis (use procedures outlined for F.M. receivers)</li> <li>2. Stereo F.M. receiver alignment</li> <li>3. Differential amplifier</li> <li>4. Servicing stereo audio amplifiers</li> </ul>	
<b>K. Tape Recorders</b>	<b>14 Hours</b>
<ul style="list-style-type: none"> <li>1. Physical layout and components</li> <li>2. Servicing and adjusting mechanical components</li> <li>3. Speed problems</li> <li>4. Bias and erase oscillators and adjustments</li> <li>5. Tape heads <ul style="list-style-type: none"> <li>(a) erase</li> <li>(b) playback</li> <li>(c) record</li> </ul> </li> <li>6. Equalization and playback response</li> <li>7. Circuit fault analysis of tape recorders</li> <li>8. Cassette recording principle — servicing</li> <li>9. Magnetism on the tape-recording principle</li> <li>10. Dolby systems</li> </ul>	
<b>SECTION THREE: TRADE MATHEMATICS</b>	<b>36 Hours</b>
<b>A. Review</b>	<b>6 Hours</b>
<ul style="list-style-type: none"> <li>1. Mathematical operations</li> <li>2. Use of calculators</li> </ul>	

3. Series, parallel and complex resistive circuits
4. Trigonometric functions
5. Vectors
6. Alternating current circuit problems
7. Resonance
8. A.C. circuit problems
9. Logarithms

**B. Decibels**

**10 Hours**

1. Development and definition
2. Decibel as a unit of sound intensity
3. Decibel as a measure of gain or loss in an electronic circuit
4. Conversion of power ratios to dB gain
5. Conversion of dB gain to power ratios
6. Use of current, voltage and impedance in calculating decibels
7. Solutions to practical electronic trade problems involving decibels

**C. Digital Basics**

**20 Hours**

1. Number systems
  - (a) review of decimal numbers
  - (b) binary numbers
  - (c) bases
  - (d) conversion between bases
2. Binary arithmetic
  - (a) addition
  - (b) subtraction (recognition)
  - (c) multiplication
  - (d) division (recognition)
  - (e) decimals (binary decimals)
3. Introduction to combinations of binary variables
  - (a) representation by positions of "N" switches
  - (b) combinations of variables determined by 2N
  - (c) combinations of combinations determined by 22N
4. Laws of Boolean algebra as applied to symbolic logic for switching circuits
  - (a) Boolean operators
  - (b) conversions
  - (c) gates in digital circuits

5. Simplifications of logic circuits
  - (a) equivalence
  - (b) Boolean Laws and rules
  - (c) Boolean identities
  - (d) DeMorgan's Theorem
  - (e) truth tables
  - (f) factoring and multiplying Boolean terms
  - (g) Venn diagrams (optional)
  - (h) trade application

## THIRD PERIOD TECHNICAL TRAINING

**SECTION ONE: T.V. RECEIVERS (THEORY) 78 Hours**

**A. Review of Television Receivers 14 Hours**

1. Stages and their functions
2. Customer controls
3. Technician controls
4. N.T.S.C. color system
  - (a) additive color fundamentals
  - (b) luminance signal
  - (c) chroma signal
  - (d) burst signal
  - (e) transmission of color information

**B. Picture Tubes 4 Hours**

1. Types and structure
2. Deflection, focusing and centering
3. Screen phosphors
4. The electron beam
5. Electrostatic focusing
6. Magnetic deflection
7. Color picture tubes
8. Picture tubes with in-line beams
9. Grid-cathode voltage on the picture tube
10. Picture tube precautions
11. Picture tube troubles

**C. The Television Receiver Sound Section 4 Hours**

1. Review of
  - (a) frequency changes in an F.M. signal
  - (b) audio modulation in an F.M. signal
  - (c) pre-emphasis and de-emphasis
  - (d) advantages and disadvantages for F.M. sound signal
  - (e) receiver requirements for F.M. sound signal
  - (f) slope detection of F.M. signal
  - (g) triple tuned discriminator
  - (h) center-tuned discriminator
2. The limiter



3. Ratio detector
4. Quadrature-grid F.M. detector
5. Complete sound — I.F. circuit
6. Sound I.F. alignment
7. Intercarrier sound
8. Intercarrier buzz

**D. Adjustments For Color Picture Tubes**

**4 Hours**

1. Color purity
2. Color convergence
3. Convergence correction waveshapes
4. Screen-grid adjustments
5. Degaussing
6. Pincushion correction
7. Overall set-up adjustments

**E. Power Supplies**

**6 Hours**

1. Function
2. Types of rectifier circuits
3. B+ supply line
4. Half-wave rectifiers
5. Full-wave center-tapped rectifier
6. Full-wave bridge rectifier
7. Voltage doubler
8. Voltage triplers and quadruplers
9. Filter circuits
10. Voltage regulators
11. Troubles in the low voltage supply
12. Hum in B+ voltage
13. Flyback high voltage supply
14. Fuses and circuit breakers

**F. Video Circuits**

**6 Hours**

1. Video amplifier requirements
2. Polarity of video signal

3. Amplifying video signal
4. Contrast controls
5. Video frequencies
6. Frequency and phase distortion
7. High-frequency response of video amplifier
8. Low-frequency response of video amplifier
9. Video amplifier circuits
10. Video amplifier stage
11. Luminance video amplifier in color receivers
12. Functions of composite video signal
13. The 4.5 MHz sound trap

**G. D.C. Level of the Video Signal**

**2 Hours**

1. Changes in brightness
2. Definitions of terms for the D.C. component
3. How a coupling capacitor blocks the average D.C. voltage
4. D.C. coupling and A.C. coupling
5. Average value of the video signal
6. D.C. insertion
7. Video amplifier D.C. coupled to picture tube

**H. A.G.C. Circuits**

**6 Hours**

1. Requirements of an A.G.C. circuit
2. Diode — A.G.C.
3. Aeroplane flutter
4. A.G.C. bias
5. Keying or gating pulses for the A.G.C. rectifier
6. A.G.C. circuits
7. A.G.C. circuits in I.C. chip
8. Transistorized A.G.C. gate and amplifier
9. D.C. voltage in the A.G.C. circuit
10. A.G.C. adjustments
11. A.G.C. troubles

**I. Sync Circuits**

**6 Hours**

1. Vertical sync of the picture
2. Horizontal sync of the picture
3. Sync separation
4. Integration
5. Noise in sync
6. Sync separator circuits
7. Phasing between horizontal and flyback
8. Sync and blanking bars on the screen
9. Sync troubles

**J. Deflection Oscillators**

**4 Hours**

1. Sawtooth deflection waveform
2. Producing sawtooth voltage
3. Blocking oscillator
4. Analysis of blocking oscillator
5. Deflection generators
6. Deflection oscillator controls
7. Synchronizing the blocking oscillator
8. Multivibrators
9. Multivibrator sawtooth generator
10. Synchronizing the multivibrator
11. Frequency dividers
12. Trapezoidal voltage waveshape
13. Incorrect oscillator frequency

**K. Horizontal A.F.C. Circuits**

**6 Hours**

1. A.F.C. requirements
2. Sync discriminator
  - (a) push-pull
  - (b) single-ended
3. Circuit or multivibrator controlled by sync discriminator
4. Reactance circuit
5. Sine wave oscillator

6. Filtering the D.C. control voltage
7. Phasing between horizontal blanking and flyback

**L. Horizontal Deflection Circuits**

**10 Hours**

1. Function of the horizontal output circuit
2. Horizontal amplifier circuit
3. Damping in the horizontal output circuit
4. Horizontal scanning and damping
5. Boosted B+ voltage
6. Flyback high voltage
7. Horizontal deflection controls
8. Deflection yokes
9. Horizontal output transformers
10. Analysis of the complete horizontal output circuit
11. S.C.R. horizontal output circuit
12. High voltage limit control
13. High voltage triplers
14. Regulation system and focus circuits
15. Troubles in horizontal deflection circuits
16. Automatic shut-down circuits

**M. Vertical Deflection Circuits**

**6 Hours**

1. Vertical output stage — circuit variations
2. Vertical output transformers
3. Vertical linearity
4. Internal vertical blanking
5. Vertical deflection circuit with blocking oscillator
6. Combined blocking oscillator and vertical amplifier
7. Miller feedback integrator circuit
8. Transistor pair in vertical output circuit
9. Complete vertical deflection circuit
10. Vertical deflection troubles

**SECTION TWO:****T.V. RECEIVERS (LAB)****72 Hours****A. F.M. Stereo Receivers****1 Hour**

1. Multiplex stereo decoder circuits
2. Matrixing systems and circuits
3. Composite amplifier circuit
4. 19 kHz pilot amplifier
5. Locking oscillator
6. Stereo detector
7. Stereo indicator amplifier
8. Alignment of F.M. Stereo receiver with emphasis on analyzing the stereo decoder circuits

**B. Cathode-Ray Tube Circuits and Troubleshooting****2 Hours**

1. Black and white C.R.T. operating conditions
2. Color C.R.T. operating conditions
3. Using a test C.R.T. and C.R.T. extension cables
4. General troubleshooting procedures
5. Circuit servicing
6. Defective C.R.T.
7. C.R.T. installation and adjustment
  - (a) black and white
  - (b) color

**C. Color Television Receiver Controls and Adjustments****6 Hours**

1. Physical layout
2. Operating controls
3. Color killer adjustment
4. Other field adjustments
5. Degaussing
6. Danger high voltage
7. Focus color set-up procedure
8. Purity adjustment
9. Gray scale set-up
10. Static convergence set-up

## **D. Power Supplies**

**4 Hours**

1. Transformer power supply for transistor receiver
2. Transformerless power supplies
3. Regulated B+ supplies
4. Waveform, voltage and resistance checks in low voltage power supply
5. Indications of circuit faults
6. Troubleshooting and servicing procedures
  - (a) dead set
  - (b) receiver blows fuse or smokes
  - (c) hum
  - (d) open filter or decoupling capacitors
7. Flyback high voltage supply
8. Fuses and circuit breakers

## **E. Video Circuits (Transistor Black & White and Color Receivers) 15 Hours**

1. Transistor video amplifier
  - (a) response characteristics
  - (b) high frequency compensation
  - (c) coupling
  - (d) contrast control
  - (e) D.C. restoration
  - (f) color receiver amplifier
  - (g) peaking control
  - (h) waveform checks in video amplifier
  - (i) measuring gain
  - (j) voltage and resistance checks
  - (k) trouble symptoms
  - (l) troubleshooting and servicing
2. Video detector and A.G.C. circuits
  - (a) automatic gain control
  - (b) delayed A.G.C.
  - (c) keyed A.G.C.
  - (d) A.G.C. adjustments
  - (e) bias box and its uses
  - (f) isolating troubles in A.G.S. circuits
  - (g) procedure for servicing A.G.S. circuits
3. Video I.F. circuits
  - (a) interstage coupling
  - (b) circuit characteristics
  - (c) waveform checks in the I.F. amplifier and detector
  - (d) D.C. voltage and resistance checks
  - (e) video I.F. circuit alignment

4. Video section servicing
  - (a) visual indications of defects in
    - (i) detector
    - (ii) video amplifiers
  - (b) general troubleshooting points
  - (c) major test points
  - (d) troubleshooting procedure
    - (i) no picture with or without sound
    - (ii) weak picture, normal sound
    - (iii) hum in picture, hum in sound, poor vertical sync
    - (iv) excessively contrasting or negative picture with poor sync
    - (v) loss of picture detail or smearing
  - (e) checking transistors for D.C. operation
  - (f) signal tracing transistor stages

#### **F. Servicing the Sync Section**

**10 Hours**

1. The sync system
2. Sync separation
3. Sync phase splitter
4. Noise inverters
5. Vertical sync
6. Horizontal sync
7. Horizontal A.F.C. adjustments
8. Waveform, voltage and resistance checks
9. General servicing procedures
10. Visual indications of sync circuit defects
11. Servicing procedures
  - (a) Loss of vertical and horizontal sync
  - (b) Loss of horizontal sync
  - (c) Loss of vertical sync
  - (d) Vertical instability
12. Miscellaneous troubles

#### **G. Servicing Vertical Sweep Section**

**10 Hours**

1. Scanning process
2. Blocking oscillator circuit
3. Generating sawtooth and trapezoidal waveform
4. Frequency calibration of oscilloscope
5. Multivibrator circuits
6. Vertical amplifier circuits



7. Pincushion adjustment circuits
8. Procedure for pincushion adjustment
9. Dynamic convergence circuitry
10. Visual indications of defects in vertical sweep circuits
11. Troubleshooting procedures

**H. Horizontal Sweep Section Servicing** **14 Hours**

1. Horizontal blocking oscillator
2. Horizontal sine wave oscillator
3. Horizontal output amplifier and H.O.T. circuits
4. Damper
5. Horizontal deflection
6. Service adjustments
7. Dynamic convergence circuits
8. Visual indications of horizontal sweep circuit troubles
9. Servicing procedures
10. Troubleshooting horizontal-sweep-section

**I. High Voltage Section Servicing** **10 Hours**

1. Physical characteristics of high voltage rectifier and its assembly
2. High voltage sections of color receivers
3. Regulator circuits
4. Voltage and resistance checks
5. Testing high voltage capacitors
6. Deflection and high voltage defects

**SECTION THREE: DIGITAL FUNDAMENTALS I** **30 Hours**  
**(LAB-LECTURE)**

**A. Digital Fabrication** **3 Hours**

1. Epitaxial process for I.C. fabrication

**B. Boolean Concepts** **7 Hours**

1. Boolean logic functions: AND, OR and NOT symbols and truth tables
2. TTL AND, OR and NOT gates, voltage level translation of symbol tables
3. DeMorgan's Law — as applied to NAND and NOR gates

**C. Combinational Logic Circuits****10 Hours**

1. Block diagram of a combinational logic circuit
2. Examples of how a truth table is translated into a NAND or a NOR circuit. Binary to decimal converter
3. 7-segment decoder and 7-segment display
4. Read Only Memory (R-O-M) as an example of a combinational logic circuit. How the 7-segment decoder can be considered an example of an R-O-M.
5. Binary to Octal conversion and converters.

**D. Digital Families****10 Hours**

1. TTL, CMOS, DTL and ECL circuits
2. Digital operating parameters

## **FOURTH PERIOD TECHNICAL TRAINING**

**SECTION ONE: COLOR TELEVISION (THEORY) 84 Hours**

**A. Picture I.F. Amplifiers 6 Hours**

1. Functions of picture I.F. section
2. Intermediate frequencies
3. Picture I.F. response
4. I.F. amplification
5. Single tuned I.F. amplifiers
6. Double tuned I.F. amplifiers
7. Stagger tuned stages
8. Wave traps
9. Picture I.F. amplifier circuits
10. Picture I.F. alignment
11. Crystal filter I.F. system
12. Troubles in picture I.F. stages

**B. The R.F. Tuner 6 Hours**

1. Operation of the R.F. tuner
2. R.F. amplifier stage
3. R.F. amplifier circuits
4. The mixer stage
5. The local oscillator
6. Automatic fine tuning (A.F.T.) and remote tuning
7. Types of R.F. tuners
8. V.H.F.R.F. tuner circuits
9. U.H.F.R.F. tuner circuits
10. Cable T.V. channels
11. Varactors for electronic tuning
12. Tuner A.F.C.
13. R.F. alignment and adjustments
14. Tuner troubles

1. Signals for color picture
2. Burst amplifier stage
3. Chroma section circuits
  - (a) chroma bandpass
  - (b) requirements of chroma amplifiers
  - (c) chroma alignment
4. Automatic chroma control (A.C.C.) circuit
  - (a) peak chroma control (P.C.C.)
5. Tint control circuits
  - (a) manual
  - (b) automatic
6. Color killer circuit
  - (a) color killer adjustment
7. The 3.58 MHz A.F.C. system
  - (a) oscillator synchronization
  - (b) ringing circuit for color oscillator
  - (c) reactance control
8. Automatic frequency and phase control (A.F.P.C.)
9. The "Y" channel amplifier
10. Chroma demodulator circuits
  - (a) X and Z demodulators
    - (i) phase shift network
    - (ii) R-Y amplifier
    - (iii) B-Y amplifier
    - (iv) G-Y amplifier
    - (v) blanker
    - (vi) alignment and adjustment
  - (b) demodulator requirements
  - (c) I.C. demodulator module
  - (d) diode demodulators
  - (e) matrixing the "Y" video and color video signals
    - (i) in picture tubes
    - (ii) in color video amplifiers
    - (iii) in the demodulators
11. Automatic brightness limiter
12. One button tuning
  - (a) preset contrast
  - (b) preset brightness
  - (c) preset color level
  - (d) preset hue and tint
13. Convergence circuits

14. Pincushion circuits
15. Servicing the color circuits

**D. Antennas and Transmission Lines (Light Coverage) 4 Hours**

1. Resonant length of an antenna
2. How multipath antenna signals produce ghosts
3. Types of antennas
4. Transmission lines
5. Characteristic impedance
6. Impedance matching
7. Antenna installation
8. Multiple installations
9. Troubles in antenna systems

**E. Cable Distribution Systems (Light Coverage) 3 Hours**

1. Head end equipment
2. Distribution of the signal
3. Distribution losses
4. System with multi-taps
5. System with single taps
6. Decibel conversion charts

**F. Television Receiver Servicing 10 Hours**

1. Troubleshooting techniques
2. Test instruments
3. D.C. voltage measurements
4. Oscilloscope measurements
5. Alignment curves
6. Signal injection
7. Color bar generators
8. Schematic diagram of a solid-state color receiver
9. Transistor troubles
10. Study of schematic diagrams by different manufacturers

<b>SECTION TWO:</b>	<b>COLOR TELEVISION (LAB)</b>	<b>66 Hours</b>
<b>A. Servicing Picture I.F. Amplifiers</b>		<b>9 Hours</b>
1. Response characteristics of picture I.F. amplifiers		
2. Tuner to I.F. coupling		
3. Interstage pix I.F. coupling		
4. Picture I.F. circuit characteristics		
5. Waveform checks in video I.F. amplifier circuits		
6. Alignment procedures in pix I.F. circuits		
7. Visual indication of defects in the pix I.F. circuits		
8. Major test points		
9. Troubleshooting procedures and techniques		
10. Signal tracing		
<b>B. Servicing the R.F. Tuner (V.H.F. and U.H.F.)</b>		<b>6 Hours</b>
1. Tuner characteristics		
2. Mechanical arrangement of different types		
3. Electrical characteristics of different types		
4. Automatic frequency control (A.F.C.)		
5. Response curves		
6. Oscillator adjustment		
7. Remote control		
8. Troubleshooting V.H.F. tuners		
(a) mechanical defects		
(b) circuit component defects		
<b>C. Color Circuits Servicing</b>		<b>10 Hours</b>
1. Video preamplifier stage		
2. Video amplifier stage		
3. Chroma bandpass amplifier stage		
4. Burst amplifier stage		
5. Color killer and automatic chroma control circuit		
6. Adjustment and servicing of		
(a) color killer		
(b) automatic chroma control (A.C.C.)		
(c) Peak chroma control (P.C.C.)		
(d) automatic tint control (A.T.C.)		

- (e) automatic brightness control
- (f) convergence circuit
- (g) pincushion circuits

#### **D. Troubles in Raster and Picture (Cause and Remedy)**

**6 Hours**

1. Raster circuit troubles
  - (a) vertical scanning circuits
  - (b) horizontal scanning circuits
  - (c) troubles in height and width
  - (d) no brightness
2. Picture troubles
  - (a) no picture
  - (b) snow in picture
  - (c) no color in picture
  - (d) overloaded picture
  - (e) smear and streaking
  - (f) ringing and bars
  - (g) sound in picture
  - (h) ghost in picture
  - (i) interference
  - (j) hum troubles

#### **E. Servicing Color Sync Circuits**

**12 Hours**

1. Operation
2. Burst separation
3. 3.58 MHz oscillator
4. Automatic frequency and phase control (A.F.P.C.)
5. Reactance control circuit
6. In-phase color killer and A.C.C. detector
7. Complete color sync section
8. Filtered burst driven color sync
9. Tint control circuits
10. Color sync alignment
11. Color sync trouble symptoms
12. Servicing color sync section

#### **F. Chroma Section Servicing**

**8 Hours**

1. Rainbow generator and its use
2. Rainbow color bar waveforms
3. Using the rainbow generator to adjust the receiver



4. Troubleshooting the chroma section
5. Symptoms analysis
6. Chroma demodulators — servicing
7. Chroma amplifiers
8. Chroma section adjustment and alignment
9. Chroma section servicing

**G. Television Receiver Servicing**

**15 Hours**

1. Using proper equipment and correct procedures practice
  - (a) servicing defective color T.V. receivers
  - (b) aligning misaligned sets
  - (c) static convergence
  - (d) dynamic convergence, etc.
  - (e) checking triplers, sweep transformers and yokes
2. Do laboratory jobs that would best meet class requirements

**SECTION THREE: VIDEO TAPE RECORDERS  
(LAB-LECTURE)**

**18 Hours**

**A. Magnetic Recording (Review)**

**10 Hours**

1. Review of magnetic recordings
2. How the signal gets on tape
3. D.C. and A.C. record bias
  - (a) basics of video recording
  - (b) F.M. video recording
  - (c) helical scan video recording
  - (d) color recording
  - (e) color playback
  - (f) record process (block diagram)
  - (g) playback process (block diagram)
  - (h) luminance recording ("Y" signal)
  - (i) chroma record

The above followed by demonstration adjustment when equipment becomes available

**B. Video Disc Recorders (Lab-Lecture)**

**8 Hours**

1. Capacitance pick-up theory
2. The video disc
  - (a) grooves
  - (b) tracking force
3. Video disc signals

4. Simplified video disc recording (block diagram)
5. Video disc player block diagram
6. Pick-up arm assembly
7. Pick-up arm components
8. Video signal pick-up (block diagram)
9. Turntable drive
10. Optical laser disc
  - (a) the laser beam
  - (b) beam guide servo
  - (c) focus servo
  - (d) slider servo
11. Signal processing circuits with block diagram
12. Laser disc slider assembly

Demonstration adjustments during lab-lecture as equipment is purchased.

<b>SECTION FOUR:</b>	<b>DIGITAL FUNDAMENTALS II (LAB-LECTURE)</b>	<b>12 Hours</b>
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<b>A. Clocked Logic Circuits</b>		<b>12 Hours</b>
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1. Flip-flop circuits — R-S, D, J-K and clocked versions of R-S, D and J-K.
2. N-stage asynchronous counters with decoders.
3. Serial and parallel shift registers.
4. Timing clock circuits.
5. The frequency counter and frequency synthesizer as examples of digital circuits.

## **SUGGESTED REFERENCE MATERIALS**

Basic Electronics — GROB — McGraw Hill — 4th Edition

Basic Electronics Lab Manual — P.B. Zbar — McGraw Hill — 3rd Edition

Basic Mathematics For Electronics — Cook and Adams — 4th Edition

Basic Television Principles and Servicing — GROB — McGraw Hill —  
4th Edition

Basic Television — Theory and Servicing/A — Text — Lab Manual —  
P.B. Zbar and P.W. Orne — McGraw Hill — 2nd Edition

Transistor Circuit Action — Veath — McGraw Hill — 2nd Edition

Basic Mathematics for Electricity and Electronics — Singer — McGraw Hill —  
3rd Edition

Basic Radio — Theory and Servicing — Lab Manual — P.B Zbar —  
McGraw Hill — 3rd Edition.

Transistor Circuit Approximations — Malvino — Prentice Hall — 3rd Edition

## **TECHNICAL TRAINING SCHOOLS**

The Electronic Technician apprenticeship training program is offered by the Alberta Manpower, Apprenticeship and Trade Certification Division. Staff and facilities for teaching the program are supplied by Alberta Manpower at:

1. Northern Alberta Institute of Technology
2. Southern Alberta Institute of Technology

## **LOCATION OF APPRENTICESHIP AND TRADE CERTIFICATION DIVISION REGIONAL OFFICES**

CALGARY

EDMONTON

FORT McMURRAY

GRANDE PRAIRIE

HINTON

LETHBRIDGE

MEDICINE HAT

PEACE RIVER

RED DEER

VERMILION

ALBERTA REGULATION 172/80  
MANPOWER DEVELOPMENT ACT  
ELECTRONIC TECHNICIAN TRADE REGULATION

1(1) In this regulation

- (a) "electronic technician" means a person engaged in the installation, repair and safety checks of radio and television receivers, recorders, phonographs and amplifiers;
- (b) "General Regulations" means the General Regulations (Alta. Reg. 43/77), as amended;
- (c) "trade" means the trade of electronic technician.

(2) The definitions in the General Regulations apply in this regulation.

AR 172/80

PART 1  
APPRENTICESHIP AND TRADE TRAINING

2 A person is eligible to be an apprentice electronic technician if he has

- (a) satisfied the requirements of section 5 of the General Regulations, and
- (b) either
  - (i) produced evidence of at least a grade 10 education with not less than a "B" standing in Mathematics 10 or its equivalent, or
  - (ii) passed an entrance examination prescribed by the Board.

AR 172/80

3(1) Subject to subsections (1.1) and (2), an employer who is a journeyman or who employs a journeyman may employ one apprentice and one additional apprentice for each additional journeyman he employs.

(1.1) If the supply of journeymen in a location where an employer is carrying on business is insufficient to permit the employer to carry out his work commitments, the Director may authorize the employer to employ apprentices in addition to those permitted under subsection (1).

(2) The Director may authorize an employer to employ an apprentice on a temporary basis in addition to those permitted under subsection (1), to be trained in a branch of the trade not engaged in by the employer to whom he is apprenticed.

(3) An apprentice employed temporarily under subsection (2) shall not, for the purposes of subsection (1), be considered to be an apprentice of his temporary employer.

AR 172/80; 353/82

4(1) The term of apprenticeship shall be 4 periods of 12 months each.

(2) Each period shall consist of not less than 1800 hours of employment, including time spent attending technical training courses prescribed by the Board.

(3) The Director may not, pursuant to section 25(1) of the Act, reduce the term of apprenticeship to be served by an apprentice to less than one period of apprenticeship.

AR 172/80

5 When a contract of apprenticeship is registered with the Director, he shall issue to the apprentice an official record book referred to in section 14 of the General Regulations.

AR 172/80

6(1) An apprentice shall not advance to the next period until the Director has authorized him to do so by making an entry in the apprentice's official record book under subsection (2).

(2) The Director shall make an entry in the apprentice's official record book authorizing advancement to the next period, when the apprentice

(a) has completed the previous period of apprenticeship,

(b) has received, in the opinion of the Director, a satisfactory report from

(i) his employer, and

(ii) the school at which he attended technical training courses prescribed by the Board,

(c) has completed the tests and examinations prescribed by the Board, and

(d) has attained pass marks prescribed by the Board in the tests and examinations referred to in clause (c).

AR 172/80

7 The official record book of an apprentice shall be kept in the possession of his employer and, upon termination of the employment of the apprentice, the employer shall present the book to him.

AR 172/80

8(1) An employer shall pay wages to the apprentice that are not less than the following percentages of the prevailing wages paid to a journeyman:

(a) 50% in the first period;

(b) 60% in the 2nd period;

(c) 70% in the 3rd period;

(d) 80% in the 4th period.

(2) Notwithstanding subsection (1), the wages paid to an apprentice shall not be less than the minimum wage fixed pursuant to *The Alberta Labour Act, 1973*.

(3) An employer is not required to pay an apprentice wages during the time that the apprentice spends attending technical training courses prescribed by the Board.

AR 172/80

9 The hours of work and working conditions of an apprentice shall be the same as those of a journeyman.

AR 172/80

## PART 2

### CERTIFICATION

10 The Director may issue the following classes of certificates in accordance with section 49 of the General Regulations:

- (a) Certificate of Proficiency;
- (b) Temporary Certificate.

AR 172/80

11 In accordance with section 50(d) of the General Regulations, the Director may issue a Certificate of Proficiency for the trade without examination to a person who holds

- (a) a Certificate of Completion of Apprenticeship in the trade issued by another province within Canada, or
- (b) a Certificate of Qualification or a Certificate of Proficiency in the trade issued by another province within Canada bearing an Interprovincial Standards Red Seal.

AR 172/80

12(1) An application to take an examination for a Certificate of Proficiency shall be made to the Director.

(2) Documentary evidence acceptable to the Director shall be presented by the applicant for an examination showing that the applicant

- (a) holds a certificate equivalent to an Alberta Certificate of Proficiency issued by a recognized provincial authority outside of Alberta, or
- (b) has at least 4 years of acceptable work experience in the trade.

(3) The applicant shall provide translations into the English language acceptable to the Director, of credentials in a language other than in English submitted pursuant to subsection (2).

AR 172/80

12.1(1) The Director may issue a Temporary Certificate to a person if

- (a) the person complies with section 12,
- (b) the Director approves the application for examination, and
- (c) the person attains a mark of not less than 70% of the passmark, on the examination prescribed by the Board for a Certificate of Proficiency.

(2) Notwithstanding subsection 1(c) the Director may, if in his opinion extenuating circumstances warrant such action, issue a Temporary Certificate to a person who has attained less than 70% of a passmark on the examination prescribed by the Board.

(3) A Temporary Certificate entitles the holder to work in the trade under the supervision of a journeyman.

AR 353/82

13 A Certificate of Proficiency issued under this regulation is effective unless cancelled or suspended by the Director in accordance with section 60 or 61 of the General Regulations.

AR 172/80

14 Regulations with Respect to the Trade of a Radio Technician (Alta. Reg. 451/67) and Regulations Governing the Trade of a Radiotechnician (Alta. Reg. 157/57), as amended, are repealed.

AR 172/80











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